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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2015/2016

PPH0125 – MECHANICS

(Foundation in Engineering - All Sections / Groups)

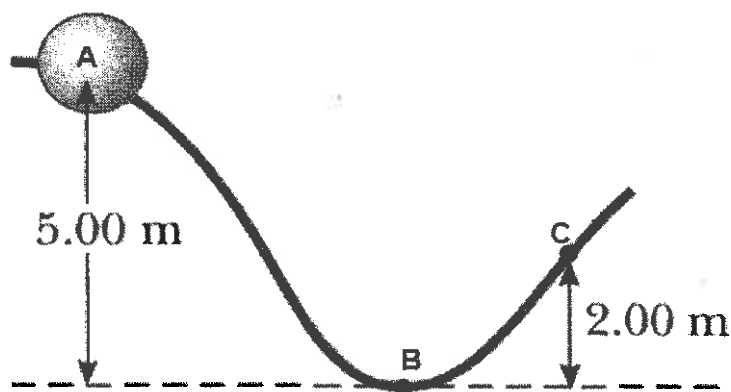
29 FEBRUARY 2016
9.00 A.M – 11.00 A.M
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of **FIVE** printed pages, excluding the cover page, Appendix I and Appendix II, with **FIVE** questions.
2. Answer **ALL** questions. The distribution of the marks for each question is given.
3. Write all your answers in the Answer Booklet provided.
4. All necessary workings **MUST** be shown.

ANSWER ALL QUESTIONS**QUESTION 1 (10 Marks)**

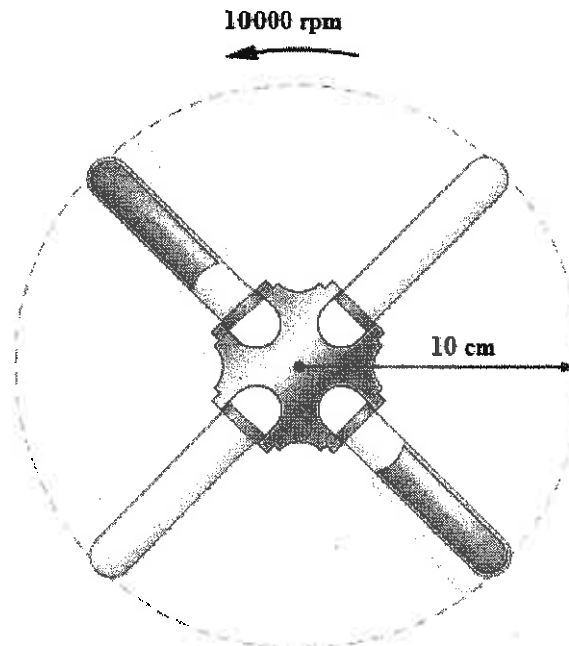
- a) State the principle of conservation of energy (2 Marks)
- b) What do you understand by the work-energy theorem? (2 Marks)
- c) A 0.4 kg bead slides on a curved wire, starting from rest at point A as shown in **Figure Q1**. If the wire is frictionless, find the speed of the bead at B and at C. (6 Marks)

**Figure Q1****Continued...**

QUESTION 2 (10 Marks)

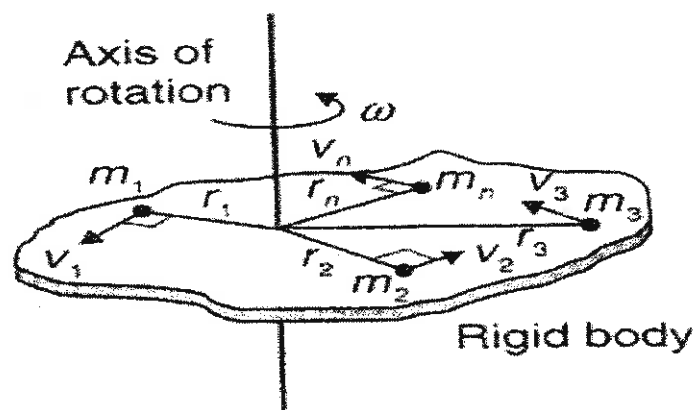
- a) The tubes in **Figure Q 2(a)** are rotating at 10000 rpm, with the bottom of the tubes 10.0 cm from the axis of rotation.
- Determine how many rotations each tube makes in one second.
 - Determine the angular frequency of the tubes.
 - Find the linear speed of the bottom of the tubes.
 - What is the centripetal acceleration at the bottom of the tubes ?

(8 Marks)

**Figure Q 2(a)**

- b) Referring to **Figure Q 2(b)**, show that the sum of the kinetic energy of n particles of the rigid body is equal to the rotational kinetic energy of the body.

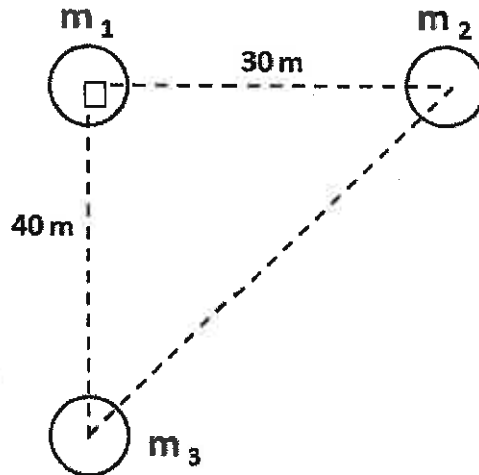
(2 Marks)

**Figure Q 2(b)**

Continued...

QUESTION 3 (10 Marks)

- a) A system of three space stations m_1 , m_2 and m_3 of masses 500 kg, 1000 kg and 1500 kg, respectively, are placed at the corners of a right triangle in the outer space as shown in **Figure Q 3**. Find the total gravitational energy of the system.

**Figure Q 3**

(3 marks)

- b) A new satellite of the Earth has a mass of 700 kg and is placed into an orbit at an altitude of 2900 km. Determine the value of g at the satellite position, the speed of the satellite orbiting the earth and the period of the satellite.

(6 marks)

- c) What do you understand by the escape velocity of an object with respect to the Earth?

(1 mark)

Continued...

QUESTION 4 (10 Marks)

- a) An experiment was done in a lab to determine the value of Young's modulus of a wire of diameter 4.0 mm. Figure Q 4(a) shows the original set up before the experiment begin. Figure Q 4(b) shows an object of mass 50 kg is suspended at the end of the wire which caused the wire to extend. Calculate the values of the stress, the strain, and the Young's modulus of the wire.

(5 marks)

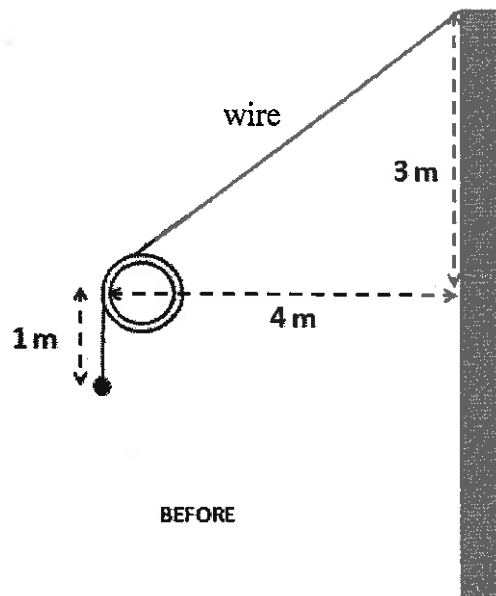


Figure Q 4(a)

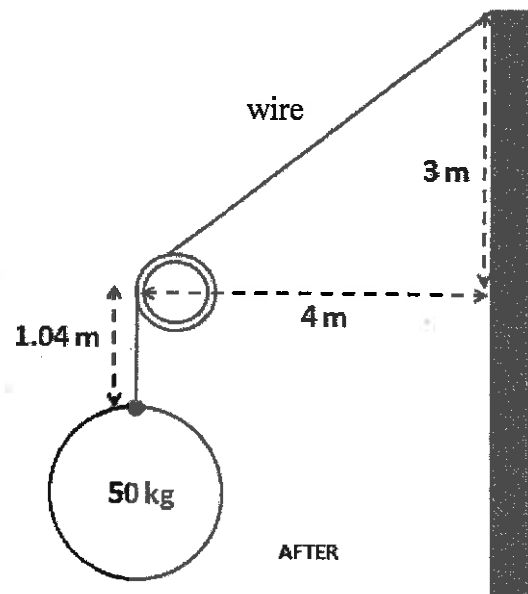
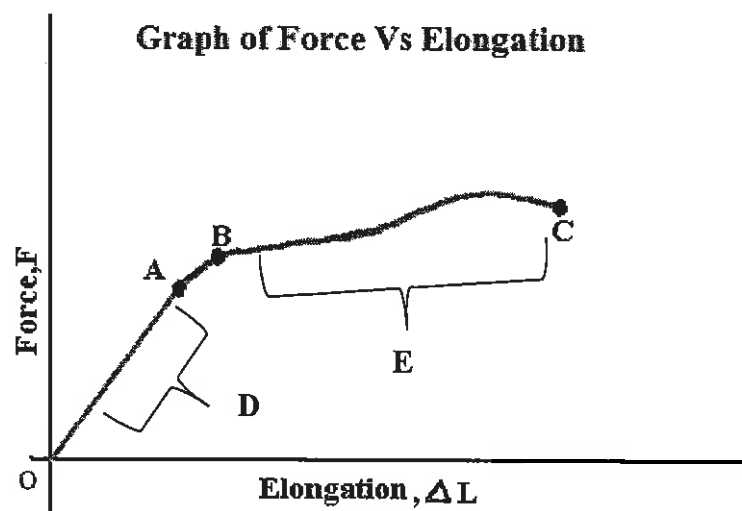


Figure Q 4(b)

- b) Figure Q 4(c) shows graph of force against elongation of a typical steel wire. State briefly the points or region labelled with A, B, C, D, and E.

(5 marks)

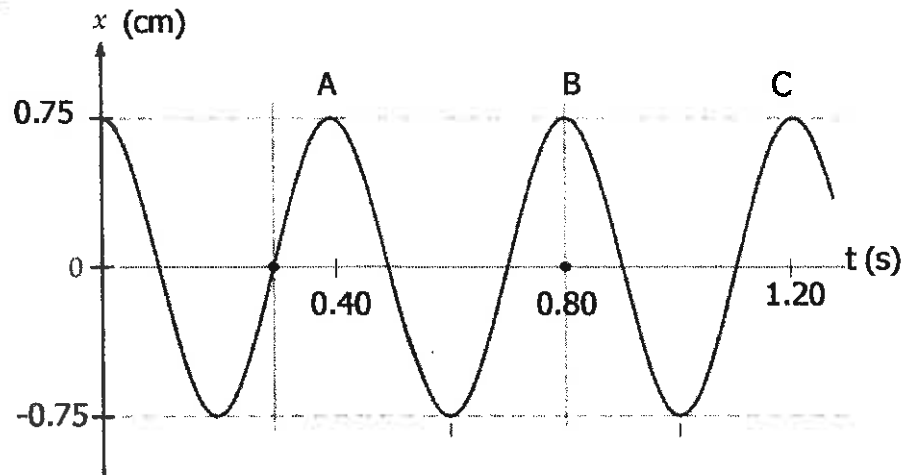


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QUESTION 5 (10 Marks)

- a) What is the difference between a periodic motion and a simple harmonic motion? (2 marks)
- b) Determine the amplitude, the period, the frequency and the angular frequency of the motion shown in **Figure Q 5(a)**.

**Figure Q 5(a)**

- c) A 50 g mass vibrates in simple harmonic motion at the end of a spring. The amplitude of the motion is 12 cm and the period is 1.70 s. Find
- the frequency of the system,
 - the spring constant,
 - the maximum speed of the mass, and
 - the maximum acceleration of the mass.

(4 marks)

End of Paper

APPENDIX I:

LIST OF PHYSICAL CONSTANTS

Electron mass,	m_e	=	$9.11 \times 10^{-31} \text{ kg}$
Proton mass,	m_p	=	$1.67 \times 10^{-27} \text{ kg}$
Neutron mass,	m_n	=	$1.67 \times 10^{-27} \text{ kg}$
Magnitude of the electron charge,	e	=	$1.602 \times 10^{-19} \text{ C}$
Universal gravitational constant,	G	=	$6.67 \times 10^{-11} \text{ N.m}^2 / \text{kg}^2$
Universal gas constant,	R	=	8.314 J/mol.K
Hydrogen ground state,	E_0	=	13.6 eV
Boltzmann's constant,	k_B	=	$1.38 \times 10^{-23} \text{ J/K}$
Compton wavelength,	λ_c	=	$2.426 \times 10^{-12} \text{ m}$
Planck's constant,	h	=	$6.63 \times 10^{-34} \text{ J.s}$
		=	$4.14 \times 10^{-15} \text{ eV.s}$
Speed of light in vacuum,	c	=	$3.0 \times 10^8 \text{ m/s}$
Rydberg constant,	R_H	=	$1.097 \times 10^7 \text{ m}^{-1}$
Acceleration due to gravity of earth,	g	=	9.80 m/s^2
1 unified atomic mass unit,	1 u	=	931.5 MeV/c^2
		=	$1.66 \times 10^{-27} \text{ kg}$
1 electron volt,	1 eV	=	$1.60 \times 10^{-19} \text{ J}$
Avogadro's number,	N_A	=	$6.023 \times 10^{23} \text{ mol}^{-1}$
Threshold of intensity of hearing,	I_0	=	$1.0 \times 10^{-12} \text{ W/m}^2$
Coulomb constant,	$k = \frac{1}{4\pi\epsilon_0}$	=	$9.0 \times 10^9 \text{ N.m}^2 / \text{C}^2$
Permittivity of free space,	ϵ_0	=	$8.85 \times 10^{-12} \text{ C}^2 / \text{N.m}^{-2}$
Permeability of free space,	μ_0	=	$4\pi \times 10^{-7} \text{ T.m/A}$
1 atmosphere pressure,	1 atm	=	$1.0 \times 10^5 \text{ N/m}^2$
			$1.0 \times 10^5 \text{ Pa}$
Earth: Mass,	M_E	=	$5.97 \times 10^{24} \text{ kg}$
Radius (mean),	R_E	=	$6.38 \times 10^3 \text{ km}$
Moon: Mass,	M_M	=	$7.35 \times 10^{22} \text{ kg}$
Radius (mean),	R_M	=	$1.74 \times 10^3 \text{ km}$
Sun: Mass,	M_S	=	$1.99 \times 10^{30} \text{ kg}$
Radius (mean),	R_S	=	$6.96 \times 10^5 \text{ km}$
Earth-Sun distance (mean),		=	$149.6 \times 10^6 \text{ km}$
Earth-Moon distance (mean),		=	$384 \times 10^3 \text{ km}$

APPENDIX II:

LIST OF FORMULAS IN MECHANICS

$y = kx^n$ $\frac{dy}{dx} = knx^{n-1}$	$\sin \theta = \frac{\text{opposite}}{\text{hypotenuse}}$	$\cos \theta = \frac{\text{adjacent}}{\text{hypotenuse}}$	$\tan \theta = \frac{\text{opposite}}{\text{adjacent}}$
$v = v_o + gt$			
$y - y_o = v_o t + \frac{1}{2} gt^2$			
$v^2 = v_o^2 + 2g(y - y_o)$			
$y - y_o = \left(\frac{v_o + v}{2} \right) t$			
$a_c = \frac{v^2}{r}$	$F_g = G \frac{m_1 m_2}{r^2}$	$U_g = -G \frac{m_1 m_2}{r}$	$T^2 = K_s r^3$
$\tau = r \times F$	$\sum \tau = \tau_{net} = I\alpha$	$I = \sum mr^2$	$v = r\omega$
$L = r \times p = I\omega$	$K = \frac{1}{2} I\omega^2$		
$T_s = 2\pi \sqrt{\frac{m}{k}}$	$T_p = 2\pi \sqrt{\frac{l}{g}}$	$T = \frac{2\pi}{\omega} = \frac{1}{f}$	
$x = A \cos \omega t$	$x = A \sin \omega t$		
$v = -\omega A \sin \omega t$	$v = \omega A \cos \omega t$		
$a = -\omega^2 A \cos \omega t$	$a = -\omega^2 A \sin \omega t$		
$v = \frac{\Delta x}{\Delta t}$	$a = \frac{\Delta v}{\Delta t}$		
$v = v_o + at$	$x - x_o = v_o t + \frac{1}{2} at^2$	$v^2 = v_o^2 + 2a(x - x_o)$	
$x - x_o = \left(\frac{v_o + v}{2} \right) t$			
$W = mg$	$\sum F = F_{net} = ma$	$f_s \leq \mu_s F_N$	$f_k = \mu_k F_N$
$p = mv$	$\sum F = \frac{\Delta p}{\Delta t}$		
$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$	$m_1 u_1 + m_2 u_2 = (m_1 + m_2) v$	$P = \frac{W}{t} = \frac{E}{t} = \frac{Fd}{t} = F\bar{v}$	
$K = \frac{1}{2} mv^2$	$PE_s = \frac{1}{2} kx^2$	$F_s = -kx$	$PE_G = mgy$